



Concept Development of Artillery Precision Guided Munitions

DRDC Valcartier

April 2010



Defence Research and
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Recherche et développement
pour la défense Canada

Canada

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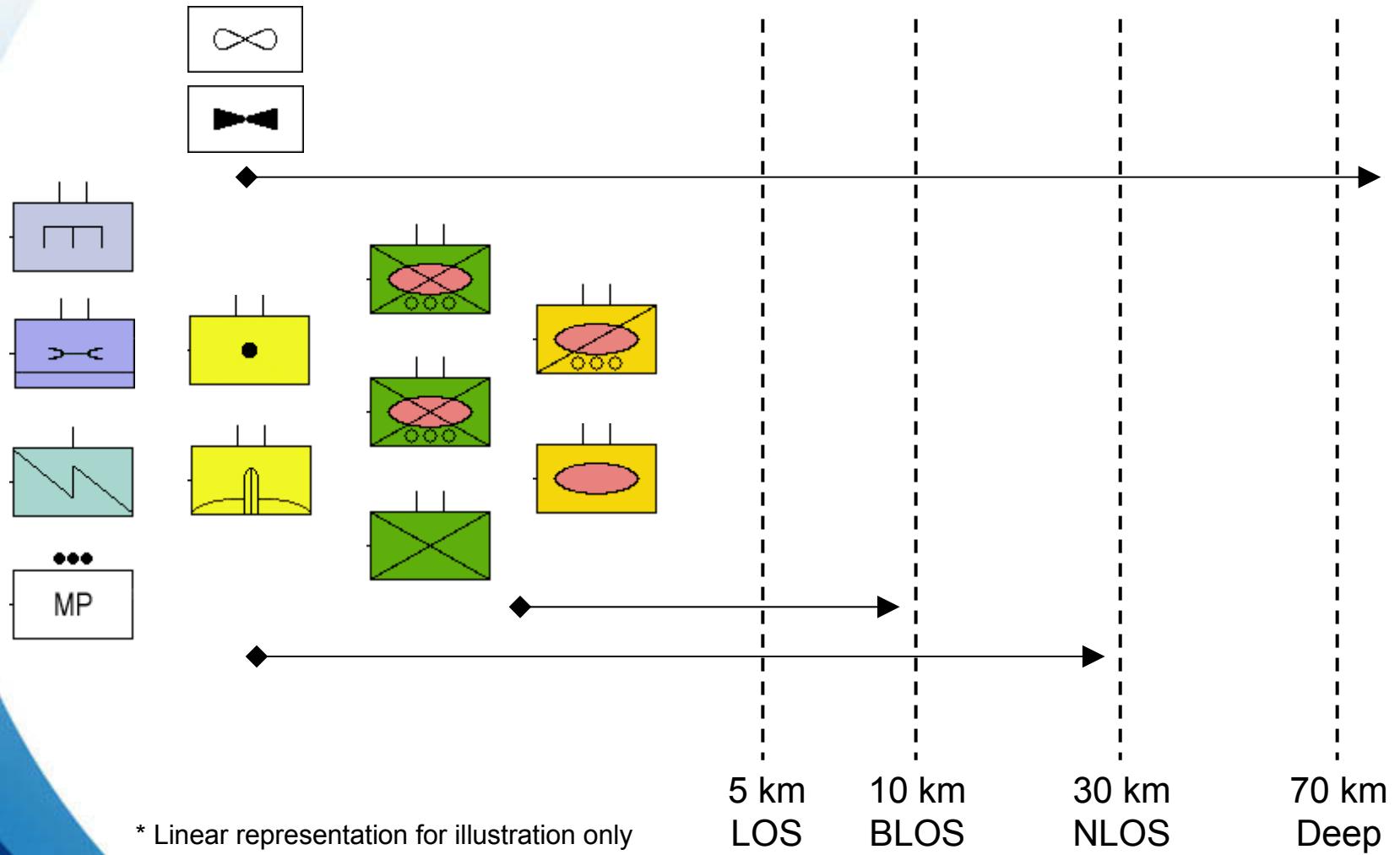
The 7 P's of Weapons Development

Purpose	Mission	
Payload	Effect on target	SCIENTIST / ENGINEER
Precision	Accuracy	
Propulsion	Range	COMMANDER / SOLDIER
Protocol	Communication	
Packaging	Logistics	
Price	Cost to benefit	

The effectiveness of future CF weapons is dependent on meaningful dialogue and interaction between the end-user of the weapons and the S&T experts who are knowledgeable about weapon technology trends.



Aggregated Formation and Area of Influence





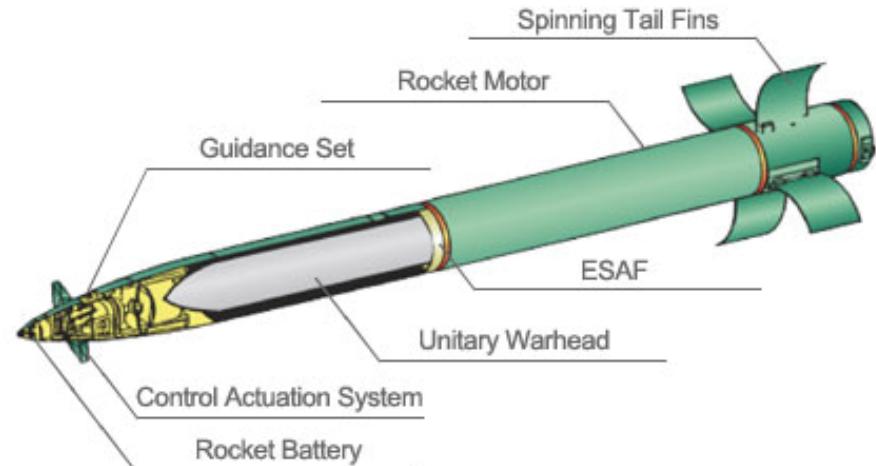
Convergence between Precision Guided Projectile and Rocket Weapons

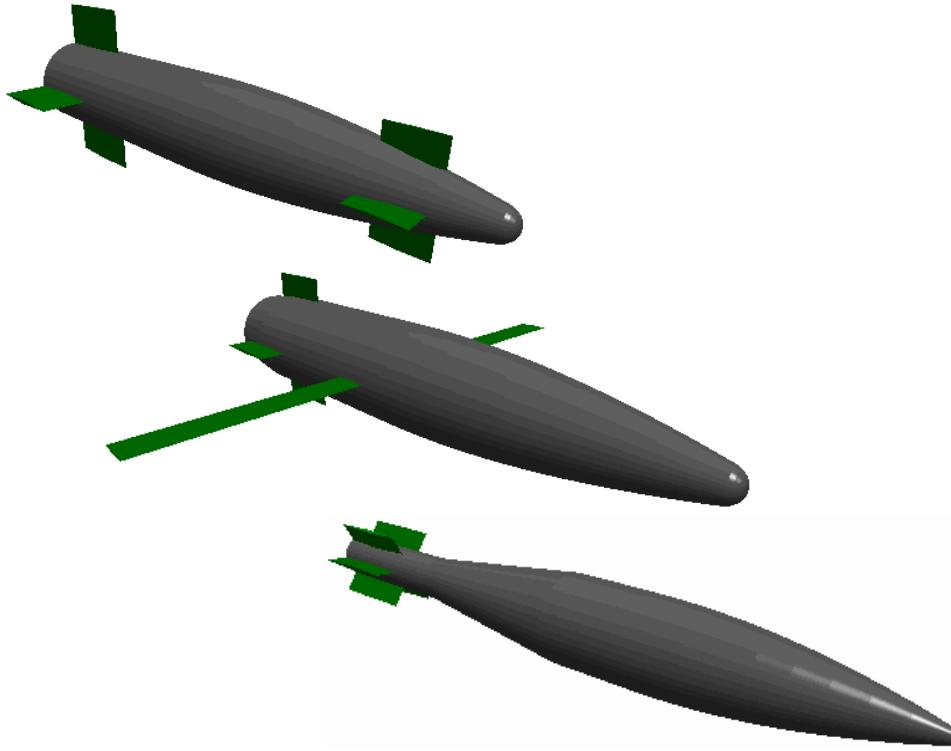


Excalibur PGM

1.0 m length
155 mm diameter
48.2 kg AUW
15 kg HE warhead (est.)
inertial and GPS guidance
canard flight control
35 km range
gun launched

Guided MLRS
3.94 m length
230 mm diameter
293 kg AUW
90 kg HE warhead
inertial and GPS guidance
canard flight control
70 km range
pod launched





Concepts for Artillery Precision Guided Munitions

Participants, resources & schedule:

- DRDC Valcartier, Honeywell, General Dynamics – Ordnance & Tactical Systems
- Project duration: April 2006 – March 2009
- Sponsor: Directorate Land Requirements

Objectives:

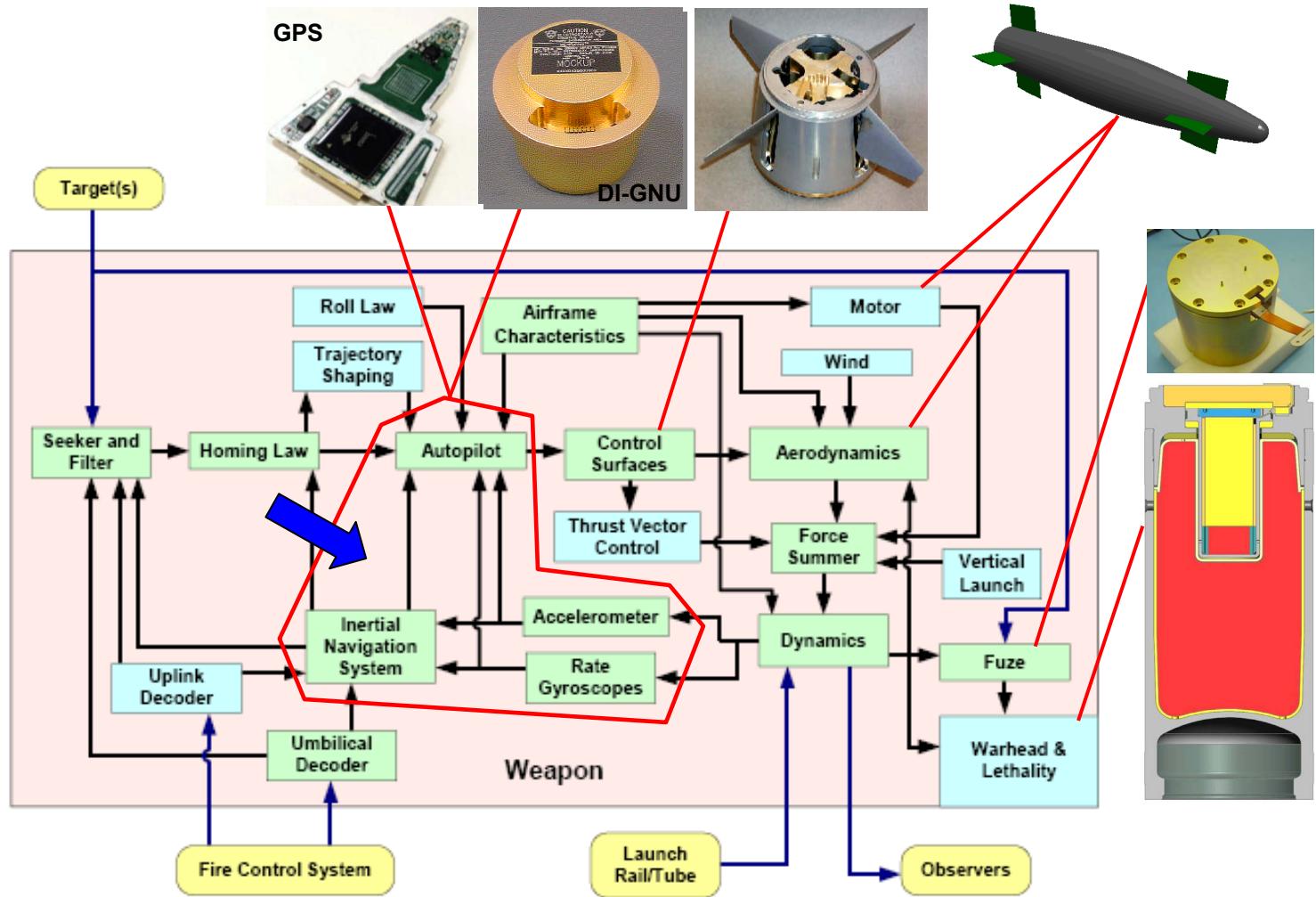
- Develop a modeling and experimentation environment that enable APGM concept evaluation and trade-off studies on sub-155mm munitions.
- Predict optimized APGM configuration and quantify inter-relationships between the components, sources of error and system performance.

Key outcomes:

- In-depth knowledge on guidance and autopilot software development for a state-of-the-art GPS/IMU device.
- Catalog of airframe and control surface concepts for a family of APGM concepts.
- Development of precision guided gun-launched projectile concepts with associated performance predictions.
- Directional warhead concepts.



Technology Options for sub-155mm Artillery Precision Guided Munitions

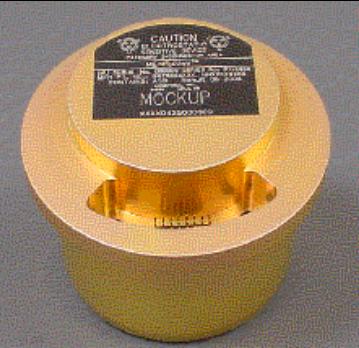




Honeywell Family of Gun-Hardened IMUs

BG1930G

- Size = 13.7 cu.in.
(2.75 in X 2.3 in)
- Gun Hard to 20,000 G
- Weight < 1 Lb
- Deeply Integrated
Guidance & Navigation
(DI-GNU)



HG1930



- Size: 4 in³ IMU
- Performance
 - G-hard to 20,000 g
 - < 20 deg/hr

DI-GNU is a tightly-coupled or ultra-tightly coupled INS and GPS system that runs all GNC functions on one microprocessor.

IGS-200 has its origins in the Common Guidance Program.

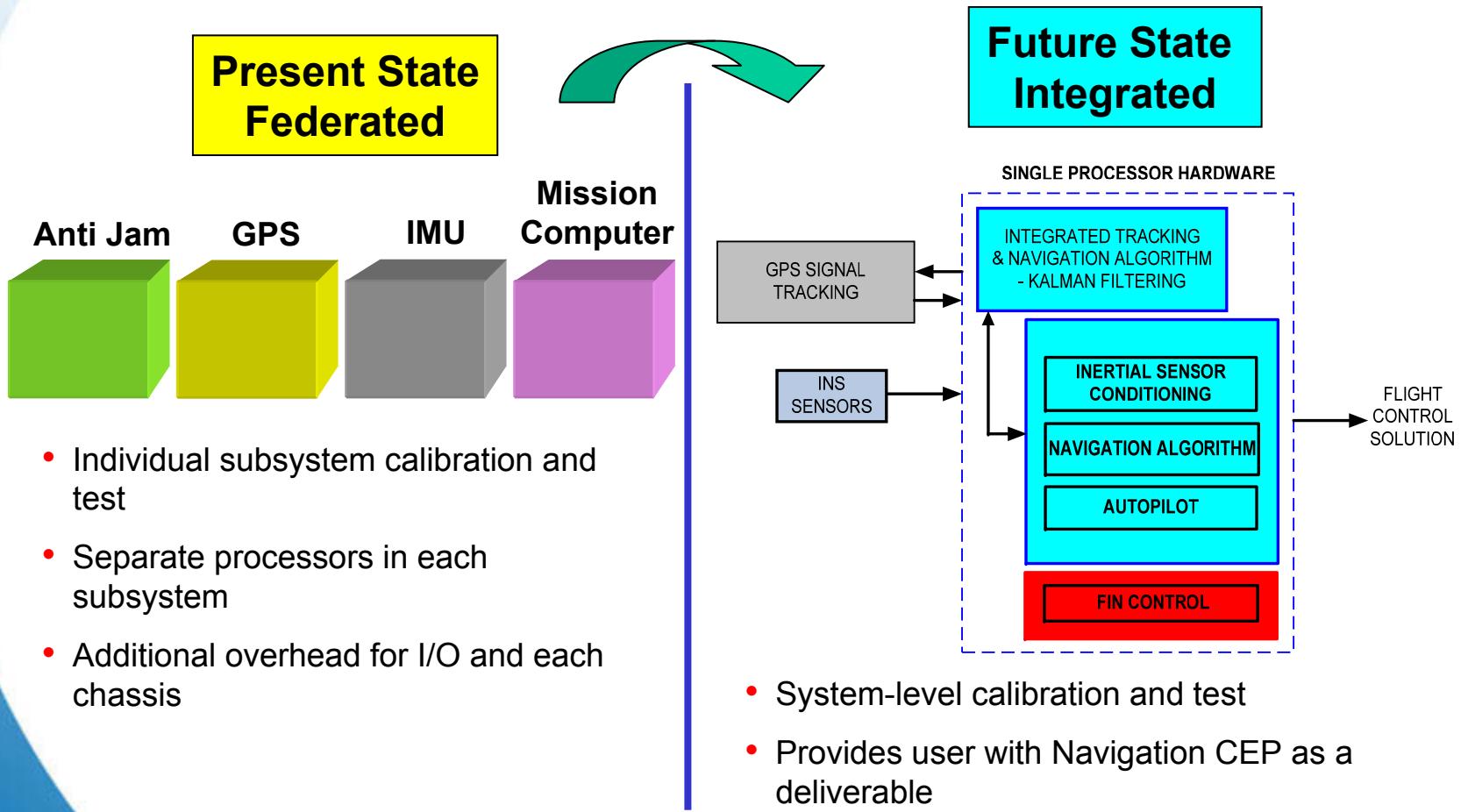
HG1940



- Size: 2 in³ IMU
- Performance
 - G-hard to 20,000 g
 - <1 deg/hr



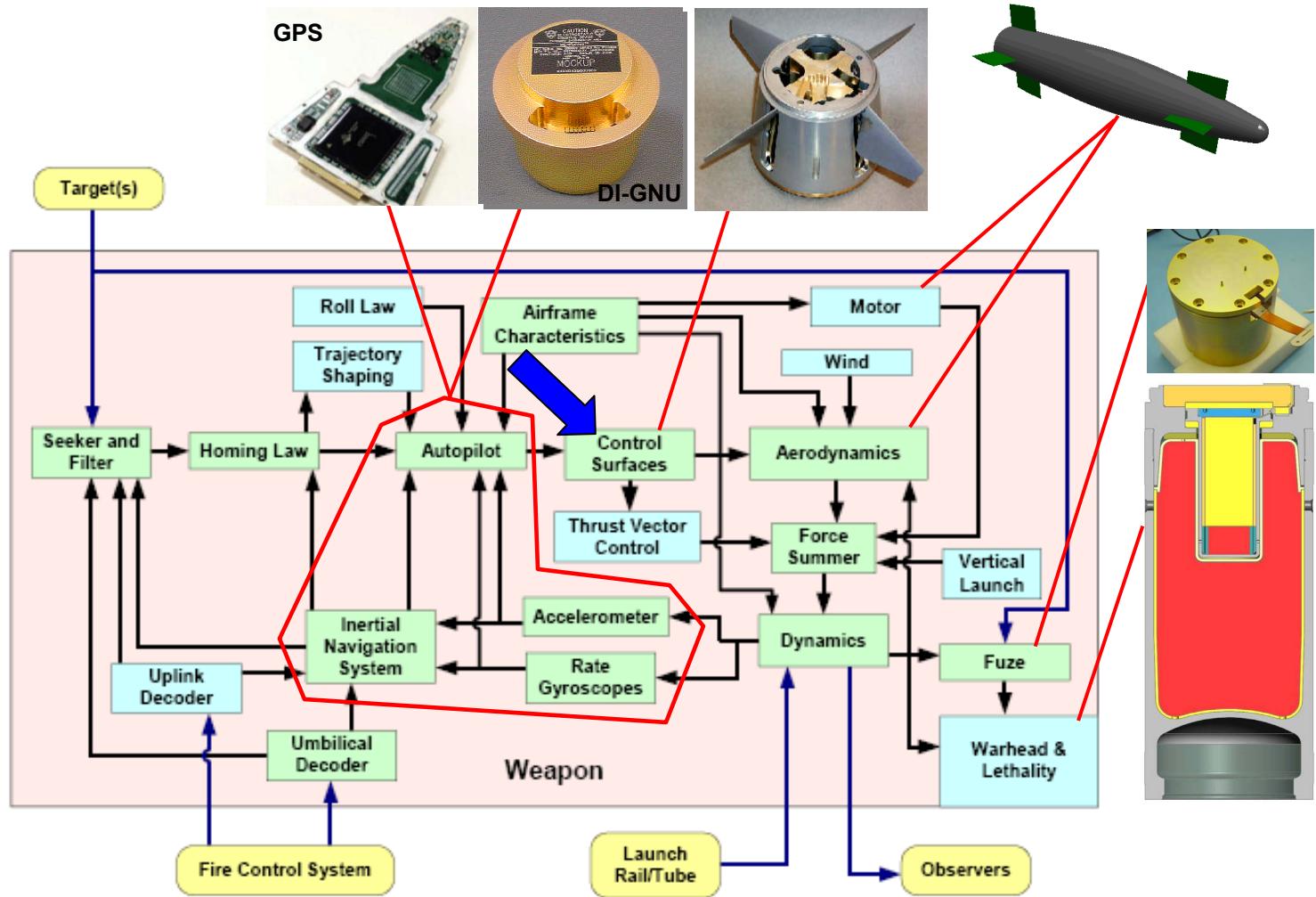
Implications of DI-GNU Structure



Honeywell



Technology Options for sub-155mm Artillery Precision Guided Munitions

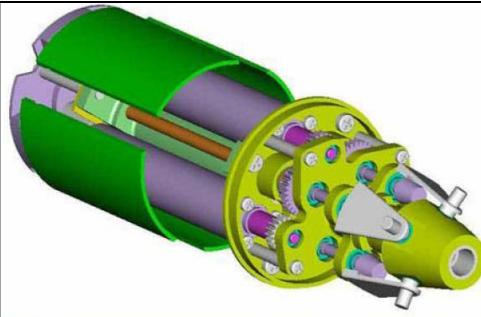




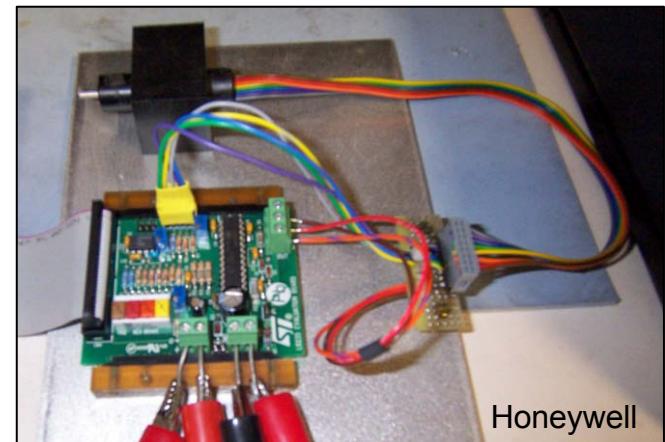
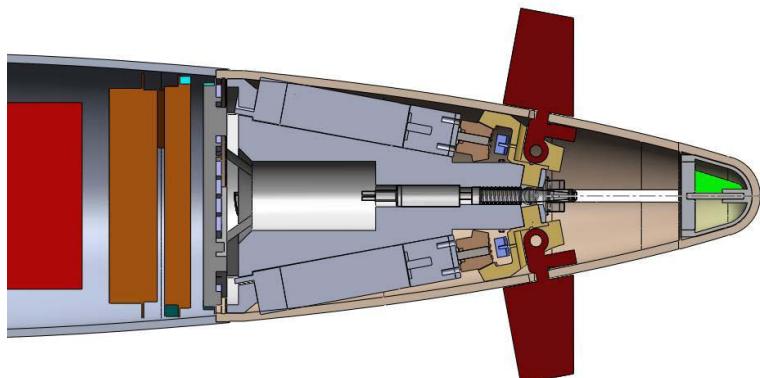
Control Actuation Systems



Honeywell



Miniaturized Electro-mechanical Body Flaps

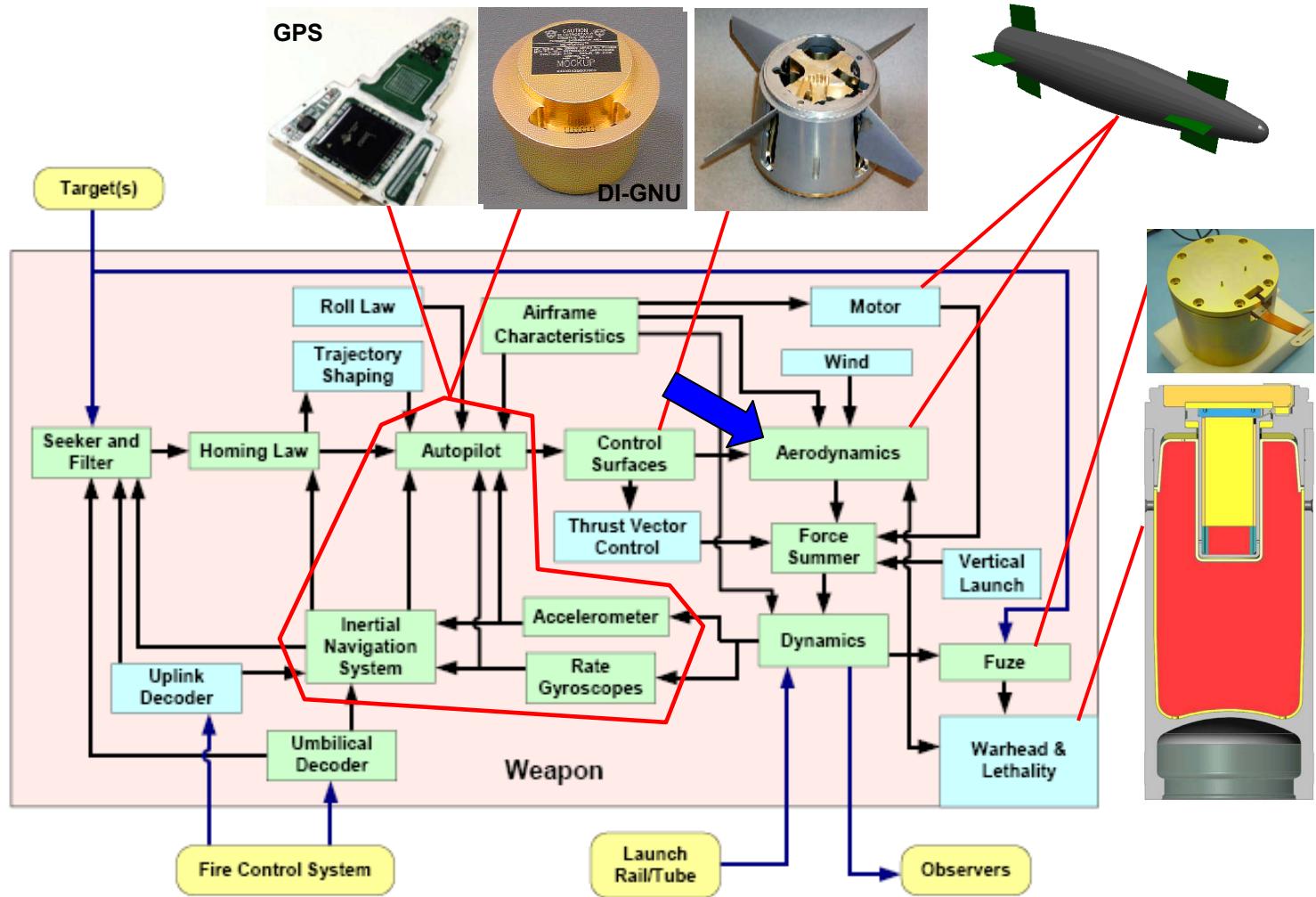


Honeywell

Miniaturized Electro-mechanical Canards

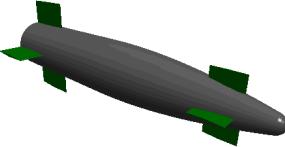
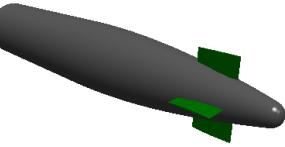
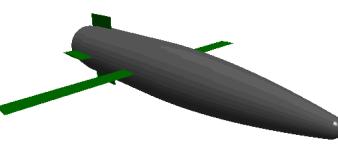
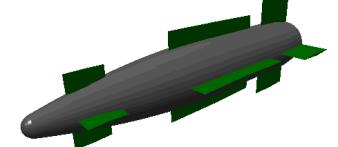


Technology Options for sub-155mm Artillery Precision Guided Munitions



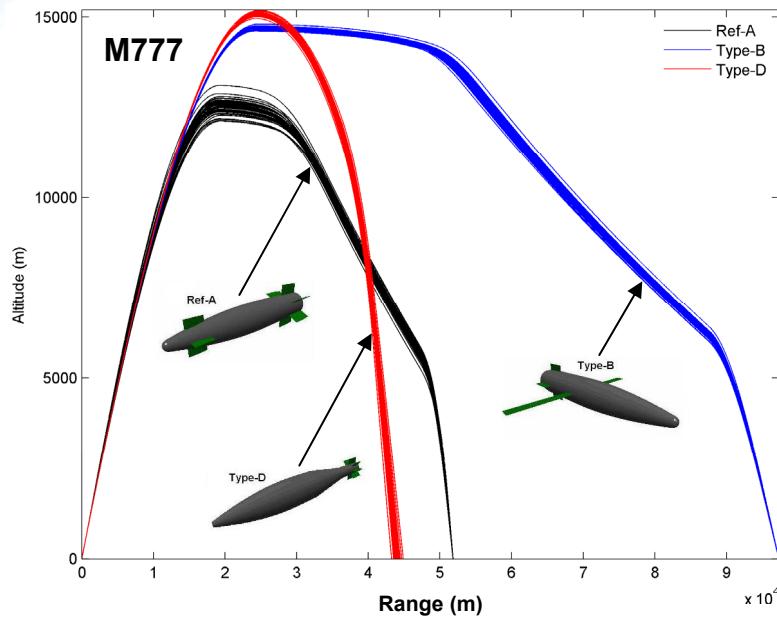


Candidate Configurations

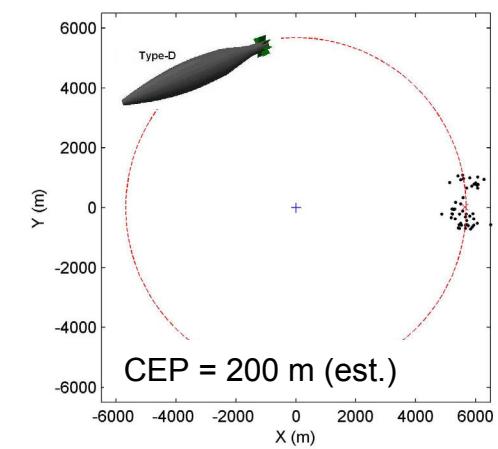
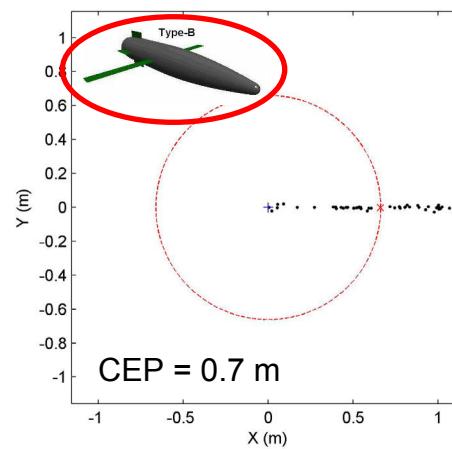
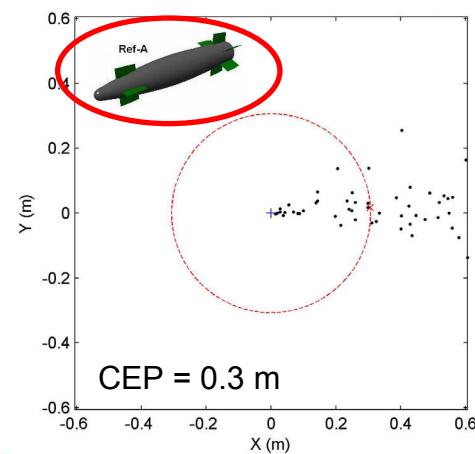
Ref A: Pseudo-Excalibur	
Ref B: Pseudo-Course Correction	
Type A: Low Drag	
Type B: Subsonic Glider	
Type C: Highly Manoeuvrable	
Type D: Robust	



Performance Study

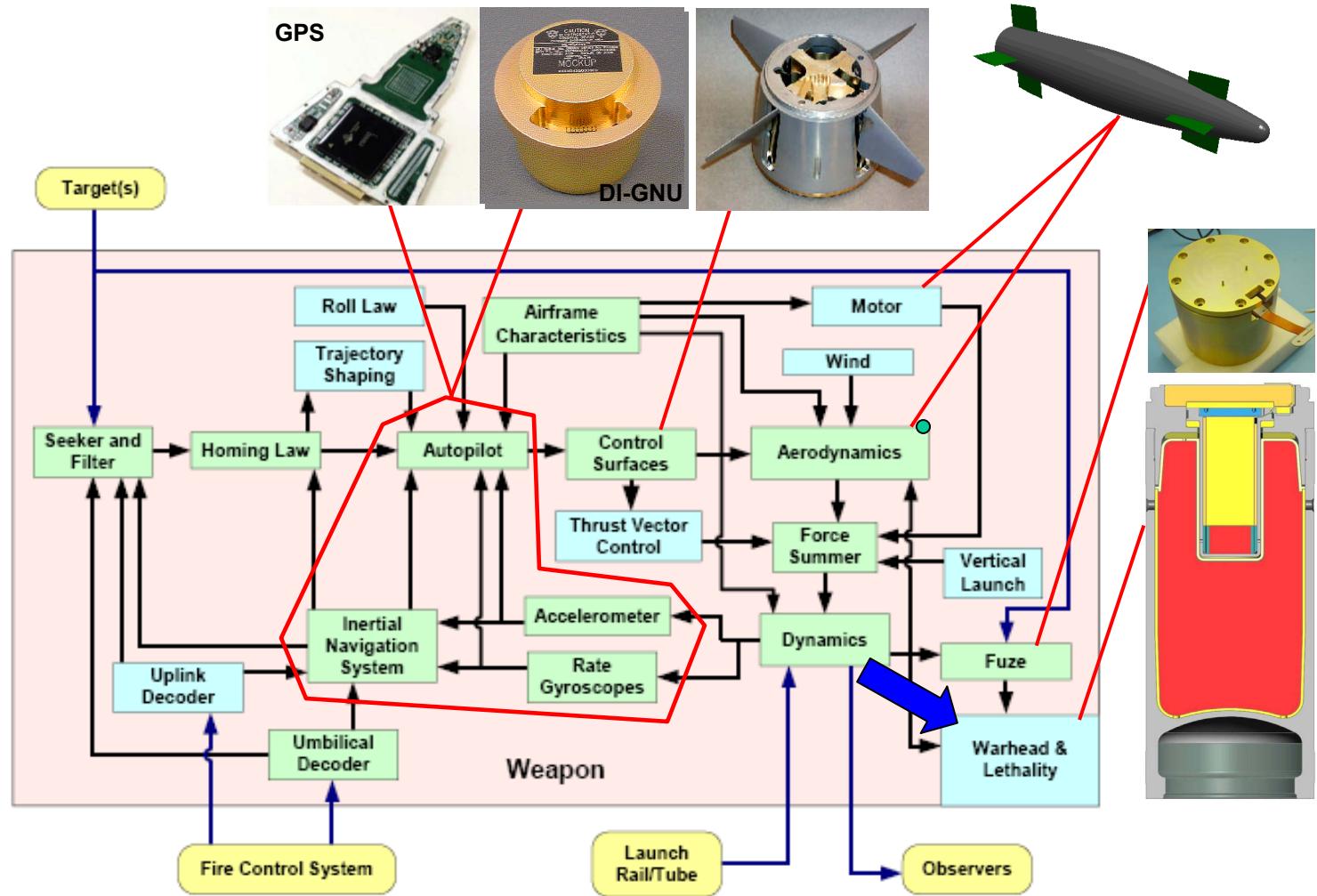


Muzzle velocity deviation = 2 m/s
Gun elevation deviation = 0.5 mils
Gun azimuth deviation = 0.5 mils
Wind speed variation = 2.8 m/s



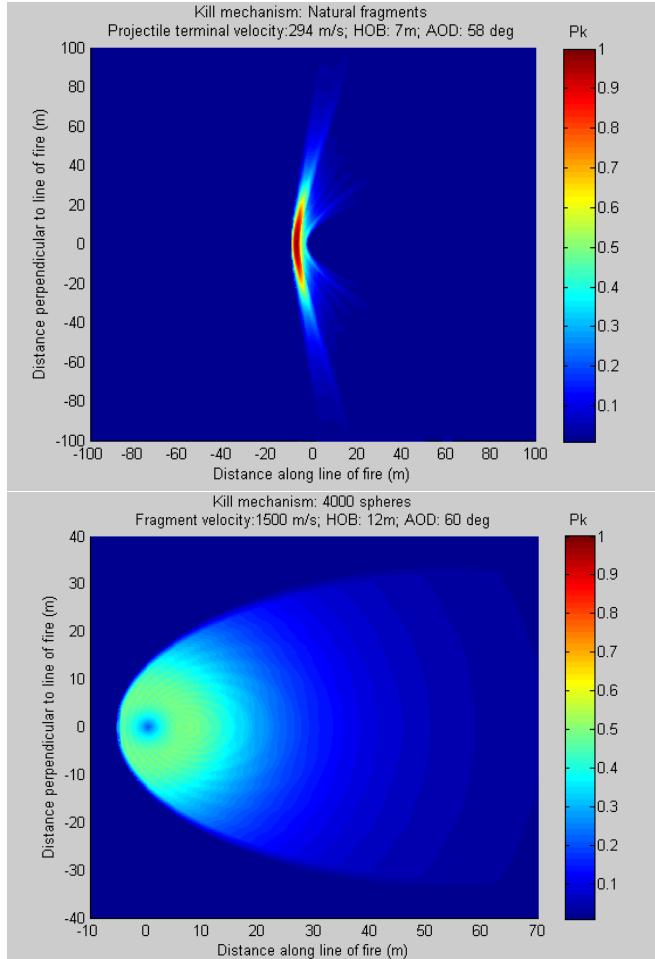


Technology Options for sub-155mm Artillery Precision Guided Munitions





Directional Warhead Concept



Current
M1



Directional
pre-formed fragments
steel spheres

Directional

Study Parameters

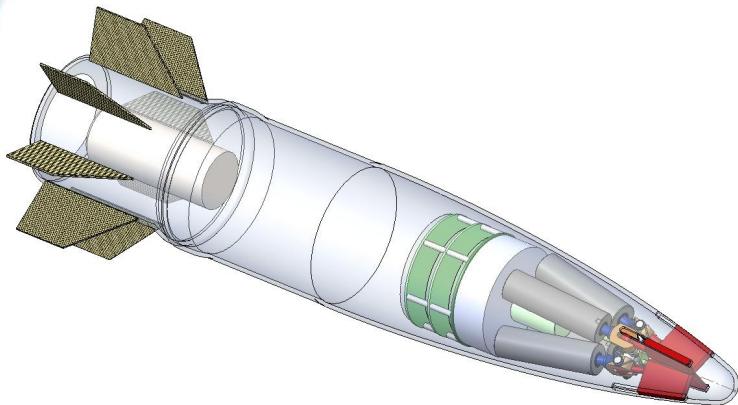
- Height of burst: 8m to 12m
- Number of fragments: 2000, 4000, 6000
- Fragment velocity: 900 and 1500 m/s
- Angle of descent: 60 and 90 deg
- Terminal velocity: 0.4 and 0.8 Mach

Results

- Large number of fragments, > 4000
- High velocity
- Angle of descent, 60 to 80 deg
- HOB can be varied to tailor effect

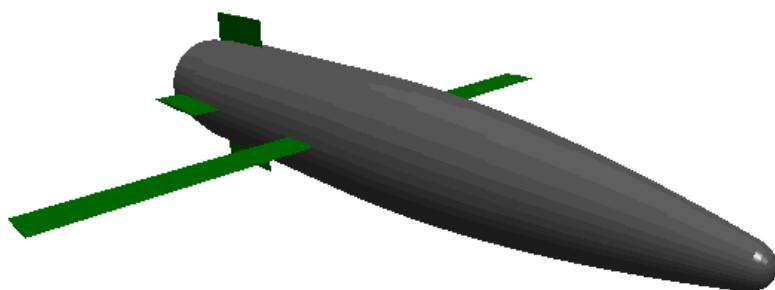


Sub-155mm Artillery PGM Concepts



105mm PGM

1.0 m length
105 mm diameter
18.5 kg AUW
6 kg HE warhead (est.)
inertial and GPS guidance
canard flight control
35+ km range
gun launched



105mm+ Glider PGM

1.0 m length
105mm+sabot diameter
20 kg AUW
6 kg HE warhead (est.)
inertial and GPS guidance
canard or tail flight control
95+ km range
gun launched



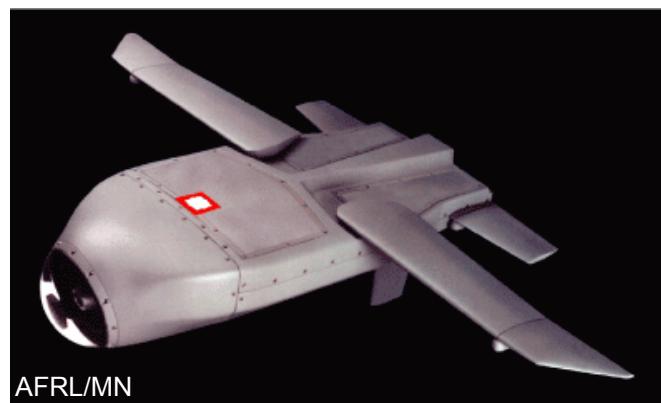
Winged Munitions



LM-Diehl

LM-Diehl M395

120mm mortar with IR seeker and wing flight control actuation system



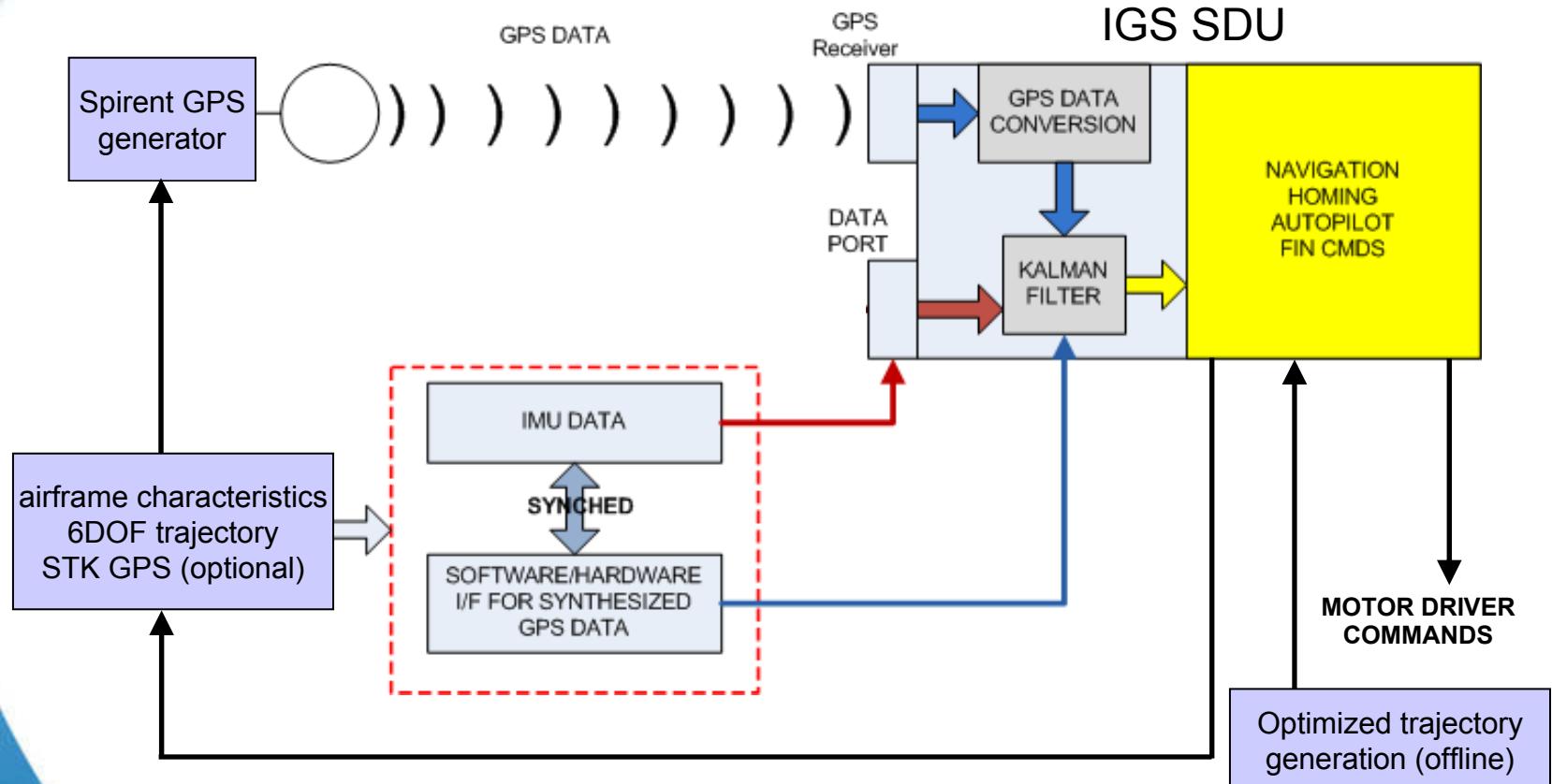
AFRL/MN

PLOCAAS

LADAR seeker, multi-mode warhead and turbo jet engine

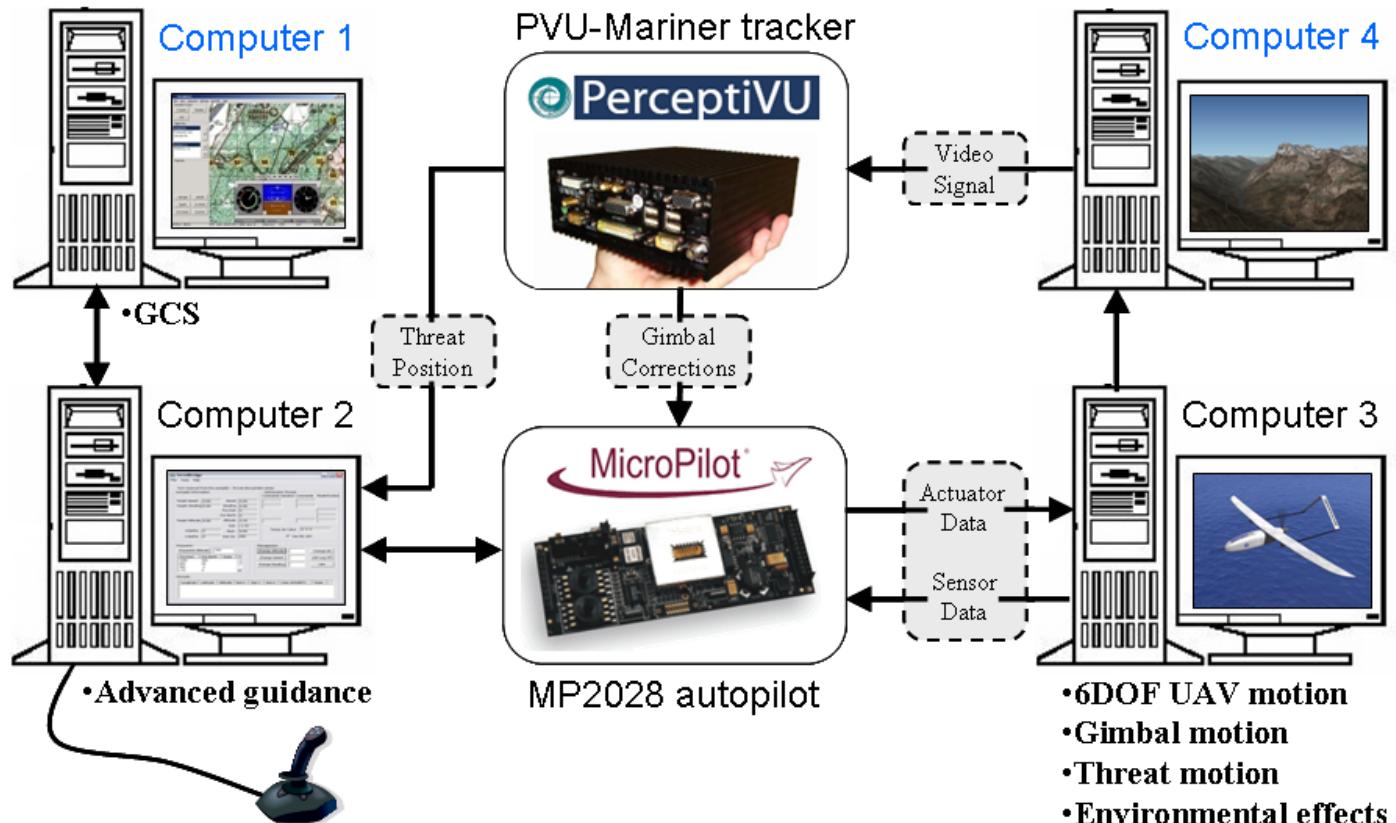


HIL IGS Layout





Target Pursuit for Marine Force Protection



Hardware-in-the-Loop facility to pursue target-of-interest using a UAV with a gimbaled camera.



Summary

- The objective of the APGM research program is to understand and develop sub-155 mm calibre PGM concepts that will demonstrate their operational capabilities to the CF Army for future acquisition programs.
- Precision guided munitions are becoming more prevalent as the number of battle successes increase and their costs diminish.
- The effectiveness of future CF weapons is dependent on dialogue and interaction between the end-user of the weapons and the S&T experts who are knowledgeable about weapon technology trends.
- DRDC has examined a number of APGM configurations and is pursuing two promising concepts that provide desired precision, range and terminal effects.